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Reasons and Risk Factors for Delayed Discharge After Total Knee Arthroplasty Using an Opioid-Sparing Discharge Protocol

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ABSTRACT

Background: In this study, we aimed to assess the length of hospital stay after total knee arthroplasty in a European healthcare setting. We also aimed to investigate risk factors and reasons for delayed discharge when using an opioid-sparing fast-track protocol.

Methods: From our institutional database, we retrospectively identified all primary elective unilateral total knee arthroplasties performed during January to December 2015. Both patient-related and surgery-related variables were collected from our databases. Risk factors were analyzed using multivariable logistic regression analysis.

Results: The median length of stay (LOS) was 3 days. Independent risk factors for delayed discharge were higher age, higher American Society of Anesthesiologists score, general anesthesia, surgery performed toward the end of the week, longer duration of surgery, longer stay in the post-anesthesia care unit, and shorter preoperative walking distance. The main reasons for delayed discharge were delayed functional recovery and pain.

Conclusion: This study identified several independent risk factors for an LOS longer than 3 days. These risk factors add to the current knowledge on which patients have an increased risk of prolonged LOS, and which patients should be targeted when striving to further reduce the LOS.

Total knee arthroplasty (TKA) is the gold standard treatment for end-stage arthritis, and is considered one of the most successful and cost-efficient surgical procedures, providing pain relief and restoring mobility. The hospital length of stay (LOS) has reduced substantially during the last decades, largely due to widespread implementation of fast-track programs, which shortens LOS and reduces costs without compromising outcomes or patient satisfaction [1–4]. Patients are usually mobilized on the day of surgery and the median LOS is usually 2 or 3 days [1,3,5–7]. Nowadays, TKA is even performed as an outpatient procedure in selected patients [8].

The demand for TKA is expected to rise [9], and as hospitals face issues of cost containment, the importance of LOS increases. Although most patients recover fast and are able to leave the hospital on the second or third postoperative day, some patients recover much more slowly and require extensive support, still barely managing to be discharged home a week after surgery. When striving to reduce the LOS, identifying and targeting these slowly recovering patient subgroups ensures that the right interventions are directed to the right patients. Furthermore, identifying the most common reasons for patients remaining longer at the ward, may give a better understanding of how to further reduce the LOS. Most studies investigating reasons and risk factors for prolonged LOS after TKA are performed in the United States, and the results may not be directly applicable in healthcare systems where everyone is insured by the government. Among other things, the Medicare payer status has been shown to influence the LOS [10].

Pain is a common concern after TKA [11]. To provide adequate pain relief and enable early mobilization, opioids are commonly used, both during the hospital stay and after discharge. According to recent studies, 86%-98% of TKA patients in the United States are discharged with strong opioids, mainly oxycodone [12,13]. Surprisingly many studies investigating LOS after fast-track TKA fail to describe which drugs are prescribed at discharge [5,6,14,15]. Prescribing strong opioids for home use enables patients to be discharged earlier, thereby reducing LOS, but the safety of liberally

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prescribing strong opioids has been acknowledged in light of the opioid crisis.

The use of strong opioids is tightly controlled in Europe. In some centers, weak opioids are preferred over strong opioids, and strong opioids for outpatient use are usually only prescribed to patients with chronic pain or end-stage cancer. The term weak opioid includes codeine, hydrocodone, and tramadol. Most other common opioids (eg, morphine, hydromorphone, fentanyl, buprenorphine, methadone, and oxycodone) are classified as strong opioids [16]. At our institution, we have a standard protocol for both perioperative and discharge pain medication after TKA, and patients are not discharged with strong opioids.

In this study, we aimed to assess the LOS after primary elective TKA using a standardized discharge pain medication that does not include strong opioids. We also aimed to identify both patient-related and surgery-related risk factors for prolonged LOS, and assess the most common reasons for delayed discharge.

Patients and Methods

We queried an institutional database for all primary elective unilateral TKA surgeries performed between January 1, 2015 and December 31, 2015. The surgeries were performed by 13 senior orthopedic surgeons specialized in joint replacement, each performing more than 100 replacements a year. LOS was counted as the number of nights between surgery and discharge. Patients who had an LOS longer than median were classified as having a delayed discharge [5,17]. These patients were then compared by multivariate logistic regression to patients with a normal discharge (ie, discharge at latest on the third day after surgery). The study protocol was approved by the institutional review board.

A fast-track protocol has been in use at our institution since 2009. Before surgery, each patient receives both verbal and written information about how to prepare for the surgery and how the rehabilitation should be performed. Patient education lectures, providing further information about the surgery, are also offered on a regular basis. During surgery, local infiltration analgesia is used for all patients: 150 mL (2 mg/mL) ropivacaine with 5 mL (0.1 mg/mL) adrenalin and 1 mL (30 mg/mL) ketorolac is injected using a systematic multipuncture technique. The first 60-70 mL is injected into the posterior capsule and posterior cruciate ligament origin before implantation of the prosthesis and the remaining 86-96 mL is injected after prosthesis implantation into ligament attachments, Hoffa's fat tissue, the joint capsule, and all surrounding tissues. Subsequently, a separate 50 mL (2 mg/mL) ropivacaine is injected into the subcutaneous wound edges. Tourniquets are used routinely for all patients. After surgery, the patients are mobilized on the same day, and thereafter receive physiotherapy (PT) once or twice daily until discharge. Stair training with a physiotherapist is mandatory prior to discharge if the patient has stairs at home. Patients are discharged when they meet all discharge criteria; they are able to walk a short distance, visit the bathroom and dress independently, the pain is in control without strong opioids, and the wound is dry.

The standard postoperative pain medication consists of 1000 mg acetaminophen 3 times a day and 600 mg ibuprofen 3 times a day. For stronger pain, patients receive oxycodone on the first postoperative day and codeine or tramadol starting on the second postoperative day. The standard thrombosis prophylaxis consists of 40 mg enoxaparin subcutaneously once daily. Tranexamic acid (1 g, intravenously) is given intraoperatively to all patients. The standardized discharge pain medication consists of ibuprofen 600 mg 3 times daily and acetaminophen/codeine 500 mg/30 mg 1 or 2 tablets 1-3 times daily. If codeine is not tolerated, the acetaminophen/codeine combination is replaced by prolonged-release tramadol 75-150 mg twice daily.

By reviewing the medical records, we evaluated the main reason for the delayed discharge. The institutional database also provided patient data, surgical data, and data from preoperative examinations. We collected the following variables: admission and discharge dates, age, gender, primary diagnosis, American Society of Anesthesiologists (ASA) score, body mass index (BMI), Knee Society (KS) knee score [18], KS functional score, preoperative walking distance, use of walking aids, preoperative pain, knee extension and flexion deficits, tibiofemoral angle, ability to climb stairs, anesthesia type, weekday and start time of surgery, duration of surgery, and time spent in the post-anesthesia care unit (PACU).

Statistical Analysis

The association of potential risk factors with LOS (>3 days vs $\leq$ 3 days) was compared with logistic regression analysis. First, univariate logistic regression was performed for each variable. The variables that had a *P*-value of less than .10 in the univariate analyses were checked for multicollinearity, and those variables that were not correlated to each other ($r < 0.50$) were included in the multivariable logistic regression analysis. Because both the KS knee and functional scores, and some of the individual elements from the KS questionnaire (eg, walking distance) were included in the univariate analyses, 2 different multivariable models were built with either KS scores or the individual variables that the KS scores are built on. The best model according to area under the curve was then chosen as the final model. The multivariable models were built by a stepwise forward procedure (inclusion criteria $P < .05$, exclusion criteria $P \geq .05$). The results are reported as odds ratio with their 95% confidence interval. All analyses were performed by an independent biostatistician using SAS System for Windows (version 9.4, SAS Institute, Cary, NC).

To estimate how different independent risk factors affect LOS, average LOS for the different risk groups was also calculated. Because LOS was skewed to the right, geometric mean was used instead of arithmetic mean. The threshold for statistical significance was set at $P < .05$.

Results

During the study period, there were 849 primary elective TKAs performed at our institution. Seven patients (0.8%) were discharged on the first postoperative day, 270 (32%) on the second, and 382 (45%) on the third day. The median LOS was 3 days (interquartile range 2-3), and this value was hence used as cut-off for normal or delayed discharge. The mean age was 67.7 years, and 68% of the patients were female. Seventy-six patients (9%) had general anesthesia and the rest of the patients had spinal anesthesia. Descriptive statistics for all patients and the 2 subgroups are presented in Table 1.

In the univariate logistic regression analysis, the following variables were significantly associated with delayed discharge: age ($P < .001$), gender ($P = .008$), ASA score ($P < .001$), preoperative walking distance ($P < .001$), preoperative use of walking aid ($P < .001$), preoperative ability to climb stairs ($P < .001$), tibiofemoral angle ($P = .002$), preoperative knee pain ($P = .005$), KS functional score ($P < .001$), KS knee score ($P = .014$), type of anesthesia ($P < .001$), day of surgery ($P = .010$), duration of surgery ($P = .007$), and time spent in PACU ($P = .026$). Surgery start after 1 PM ($P = .082$) had a *P*-value of less than .10 and was therefore included in the multivariable analysis although it was not significant in the univariate analysis. Body mass index ($P = .497$) and primary diagnosis ($P = .339$) were not significantly associated with delayed discharge and were therefore excluded from further analyses.

Table 1
Descriptive Statistics for Patients With Normal vs Delayed Discharge.

Variable	All Patients	LOS ≤3 d	LOS >3 d
n	849	659	190
LOS (d)	3.15 (1-15)	2.57 (1-3)	5.17 (4-15)
Age (y)	67.7 (33-93)	66.0 (33-92)	73.2 (41-93)
BMI (kg/m2)	29.7 (15.8-47.8)	29.8 (16.4-46.7)	29.5 (15.8-47.8)
Gender, % female	67.8%	65.6%	75.8%
Preoperative ASA score			
1-2	37.8%	44.8%	13.7%
3-4	62.2%	55.2%	86.3%
KSS functional score	55.6 (0-100)	58.9 (0-100)	44.4 (0-100)
KSS objective	36.0 (0-90)	36.9 (0-90)	33.2 (0-85)
Duration of surgery	97.2 (50-309)	95.7 (50-218)	102 (53-309)
PACU time	2.12 (0.0-6.2)	2.06 (0.10-6.20)	2.34 (0.00-5.50)
Anesthesia type			
Spinal	91.0%	93.0%	84.2%

Values are reported as mean (range) or percentage
ASA, American Society of Anesthesiologists; BMI, body mass index; KSS, Knee Society Score; LOS, length of stay; PACU, post-anesthesia care unit.

The final multivariable model identified the following independent risk factors for delayed discharge: higher age, higher ASA score, shorter preoperative walking distance, use of general anesthesia, longer duration of surgery, longer time spent in PACU, and surgery performed toward the end of the week (surgery performed on Wednesday through Friday increased the risks of delayed discharge compared to surgery performed on Monday or Tuesday). *P*-values, odds ratios, and 95% confidence intervals are presented in Table 2. As an estimation of the effect of these significant independent risk factors, the average LOS for each risk group is presented in Table 3.

A medical reason delaying the discharge was found in 80.0% of the cases. The most common reasons were delayed functional recovery (59 patients, 31.1%), pain (22 patients, 11.6%), fever or infection suspicion (9 patients, 4.7%), and wound drainage (8 patients, 4.2%). The most common nonmedical reasons for delayed discharge were the patient's own wish to stay (15 patients, 7.9%) and waiting for PT or discharge to further care (4 patients, 2.1%).

Table 2
Independent Risk Factors for Delayed Discharge According to the Final Multivariable Regression Model.

Risk Factor	OR (95% CI)	*P*-Value
Age		<.001
vs <60		
60-64		.909[a]
65-69		.197[a]
70-74		.111[a]
75-79	2.74 (1.39-5.37)	.003
≥80	7.99 (3.97-16.1)	<.001
ASA score		
3-4	3.18 (1.95-5.18)	<.001
Walking distance		<.001
vs >1 km		
500-1000 m		.294[a]
<500 m	2.05 (1.27-3.32)	.004
Housebound or unable	4.33 (2.17-8.63)	<.001
Anesthesia		
General	3.00 (1.67-5.37)	<.001
Duration of surgery (min)	1.01 (1.00-1.02)	.007
Time spent in PACU (h)	1.39 (1.13-1.70)	.002
Day of surgery		
Wednesday through Friday	1.57 (1.06-2.33)	.026
vs Monday-Tuesday		

ASA, American Society of Anesthesiologists; CI, confidence interval; OR, odds ratio; PACU, post-anesthesia care unit.
[a] Nonsignificant.

Table 3
Estimation of How Significant Independent Risk Factors Affect LOS Compared to Lowest Risk Group.

Risk Factor	Mean LOS (d)[a]	LOS Change (d)[a]
Age		
<60	2.61	
75-79	3.08	+0.47 (18%)
≥80	3.81	+1.20 (46%)
ASA score		
1-2	2.56	
3-4	3.16	+0.60 (23%)
Walking distance		
>1 km	2.63	
<500 m	3.14	+0.51 (19%)
Housebound or unable	3.92	+1.29 (49%)
Anesthesia		
Spinal	2.89	
General	3.29	+0.40 (14%)
Duration of surgery[b]		
≤120 min	2.88	
>120 min	3.10	+0.22 (7.6%)
Time spent in PACU[b]		
≤3 h	2.86	
>3 h	3.29	+0.43 (15%)
Day of surgery		
Monday to Tuesday	2.81	
Wednesday to Friday	2.99	+0.18 (6.4%)

LOS, length of stay; ASA, American Society of Anesthesiologists; PACU, post-anesthesia care unit.
[a] LOS reported as geometric mean and change (%) from lowest risk group.
[b] Variable analyzed as continuous in multivariable analysis and split into groups to improve the readability of this table.

Discussion

In this study, we sought to identify reasons and risk factors for delayed discharge after primary TKA at an institution using a standard discharge pain medication without strong opioids. We identified several independent risk factors for delayed discharge, and determined the main reasons for prolonged LOS. These results add to the current understanding of which factors prolong LOS after TKA, and can be used when striving to further reduce LOS. In contrast to many previous studies, our study is performed in a single-payer healthcare system. Payer status has been shown to affect LOS [19], which is not the case in our study. Interestingly, despite the differences in healthcare systems, we still seem to face similar challenges. The LOS in our study is in line with what has recently been reported in different parts of the world (Table 4).

Length of Stay

The median LOS was 3 days, which is similar to what has been reported in the recent literature [1,3,5,6,10]. A few studies report a median LOS of 2 days [7,15]. In our study, although 33% of the patients were discharged within 2 days of surgery, a large proportion of the patients (45%) were discharged on the third day. Although outpatient TKA is gaining popularity in selected patients at some institutions [8], we do not perform TKA as an outpatient procedure and hence no one was discharged on the day of surgery.

In recent years, increasing attention has been given to hospital LOS as a surrogate marker for quality of care. LOS would be a good marker for quality since it is more objective than coded complications such as infections and readmissions. Some studies suggest that prolonged LOS is highly sensitive as a surrogate measure for complications, which captures most complications after routine surgical procedures, especially coronary artery bypass grafting and colon resection [20]. However, according to other studies, prolonged LOS seems to correlate poorly with relevant complications in elective arthroplasty surgery [21]. Since there is no conclusive

Table 4
Risk Factors for Prolonged LOS Following Primary TKA, Published During the Last 5 Years.[a]

Author	Year	Journal	Country	No. of Patients	Risk Factors Identified	Mean LOS (d)
Abola et al	2019	J Knee Surg	USA	88,103	Hyponatremia	N/A
Boylan et al	2017	J Arthroplasty	USA	115,053	Late week surgery	3.3
Halawi et al	2015	J Arthroplasty	USA	260	Higher number of comorbidities, lack of assistance at home, bilateral TKA	3.0
Ifeoma et al	2015	J Arthroplasty	USA	2638	Lower SES, female gender, higher age, non-Caucasian ethnicity, certain comorbidities, longer operating time, higher ASA score	N/A
Ihekweazu et al	2018	World J Orthop	USA	806	Bilateral TKA, female gender, higher age, allergies, later procedure end-times, being black or African American, not being married	2.0[b]
Lo et al	2017	Hong Kong Med J	Hong Kong	1622	Higher ASA score, bilateral TKA, in-patient complications, need for blood transfusion, postoperative ICU admission, urinary catheterization	6.8
Maiorano et al	2017	Knee	Italy	353	Higher age, lower MBI score	14.9
Mathijssen et al	2016	Knee Surg Sports Traumatol Arthrosc	The Netherlands	879	Higher age, female gender, higher ASA score, living alone, neurological comorbidities, general anesthesia, late week surgery	2.9
Murphy et al	2018	Bone Joint J	Australia	2838	Higher age	4.0[b]
Patterson et al	2018	J Arthroplasty	USA	214,005	Dialysis dependence	3.1
Pugely et al	2014	Clin Orthop Relat Res	USA	516,745	Multiple comorbidities, higher age, Hispanic ethnicity, black race, discharge to further care	N/A
Rhee et al	2018	Can J Surg	Canada	17,243	Higher age, multiple comorbidities, blood transfusion, female gender	5.1
Runner et al	2017	J Arthroplasty	USA	27,447	Higher Modified Frailty Index	N/A
Sikora-Klak et al	2017	J Arthroplasty	USA	2009	Higher age	2.4
Zhang et al	2018	J Orthop Surg Res	China	241	Valgus deformity, increased interleukin-6 levels, increased VAS pain score and CRP postoperatively, postoperative wound complications	3.8

ASA, American Society of Anesthesiologists; CRP, C-reactive protein; ICU, intensive care unit; LOS, length of stay; MBI, Modified Barthel Index Score; N/A, not applicable; SES, socioeconomic status; TKA, total knee arthroplasty; VAS, Visual Analogue Scale.
[a] According to PubMed results with the search phrase "length of stay AND total knee arthroplasty AND risk factor."
[b] Median.

evidence, LOS should probably not be used as a direct surrogate for surgical quality and basis for resource allocation. If, on the other hand, readmissions, infections, patient satisfaction, and mortality are all on an acceptable level, then lower LOS would be indicative of a well-functioning fast-track protocol. Shorter LOS per se seems to increase patient satisfaction [22], and longer LOS has been linked to higher risk for complications, such as unplanned readmissions [23]. As shorter hospital stay also reduces the costs [4], it is still a good objective for hospitals to continuously strive for lower LOS.

Risk Factors for Delayed Discharge

According to our results, and those of previous studies [5,10,24,25], it is evident that higher age alone is a significant risk factor for longer LOS. As TKAs are performed on increasingly older patients, this issue is of great importance. Although a non-modifiable risk factor, using clear cut-off values when the risk increases substantially (eg, 75 or 80 years according to our results), could trigger a "higher age TKA protocol." This patient group could then receive extensive care and support from the first day of surgery, and pre-emptive actions could also be taken to help reduce the risk of delayed discharge. Furthermore, more personnel could be scheduled, if it is known that a larger proportion of older patients will undergo TKA at a specific time point. As older patients usually have more medications, it may be useful to consult a geriatric specialist to reduce the risk for potential drug interactions and side effects. Patients with high ASA scores (3 or 4) could similarly be assigned to either the same or another "high-risk" group with special needs for support and monitoring. Based on the results of our and previous studies, there seems to be a need to adjust for higher age when allocating resources in bundled payment systems.

To our knowledge, preoperative walking distance has not been reported as an independent risk factor for prolonged LOS after TKA. The use of walking aids, however, has been reported to increase LOS [24,25]. Although these 2 variables are certainly interconnected, according to our analyses it seems that preoperative walking distance better predicts delayed discharge than the use of walking aids. It is tempting to hypothesize that preoperative rehabilitation with the focus to increasing walking distance could shorten the LOS, although this has to be tested in further studies. A recent meta-analysis investigating the effect of preoperative PT on outcomes after TKA concluded that preoperative PT yielded a significant decrease in LOS for TKA patients [26]. However, as the PT programs did not especially target patients with low preoperative walking distance, the real effect of this hypothesis remains unknown. As the use of wearable technology such as activity trackers increases, the data from such devices can potentially further assist in preoperative risk stratification as well as serving as a valuable aid during the recovery process [27].

In the current study, general anesthesia was a risk factor for prolonged hospitalization. This supports previous findings in a similar study of 879 consecutive TKAs performed at a teaching hospital in the Netherlands [14]. Previous research has also shown that general anesthesia appears to perform worse than spinal anesthesia in total knee replacement with regard to postoperative infections, renal failure, mortality, and LOS [28].

Longer PACU time has, as far as we know, not previously been linked to an increased likelihood of delayed discharge. Prolonged PACU stay is likely due to anesthesia-related issues such as low oxygen saturation or pain [29], which may reduce the likelihood of same-day mobilization, and subsequently hinder the in-hospital recovery process. Identifying and addressing the issues that lead to prolonged PACU stay could help reduce the overall LOS. Furthermore, based on our results, prolonged PACU stay should function as an early warning sign for patients who are at higher risk for delayed discharge and therefore need extra attention at the ward.

Late week surgery was significantly associated with prolonged LOS in our study. This is most likely due to reduced nurse and PT staffing during the weekend. At our institution, nurses are allowed to discharge patients provided discharge criteria are met. As the ward is generally less occupied during the weekend there is less pressure to discharge patients, especially if the patients do not feel confident enough to leave the hospital. The average LOS between early and late week surgeries differed by only 4.3 hours, but when using standardized discharge criteria such differences should not exist. At one arthroplasty hospital in Denmark [15], surgery is only performed from Monday through Wednesday, and the ward is closed during the weekend. In this way, reduced staffing on the weekend does not hinder postoperative rehabilitation. The effect of weekday on LOS seems to vary among different hospitals and regions. Most studies have shown that LOS varies depending on which day of the week the surgery is performed [24,30,31], but there is also conflicting evidence [32].

Reasons for Delayed Discharge

The goal at our institution during the study period was to discharge patients on the second or third postoperative day. About half of the patients in our study were discharged later than the third postoperative day due to mobilization or pain-related issues. As this was a retrospective study, we were not able to clearly distinguish what caused delayed functional recovery. According to a prospective study by Husted et al [15], the main reasons for not being discharged on time were pain, dizziness, and general weakness. These results are likely applicable to our study as well, as we use a similar fast-track protocol. In the same study by Husted et al, about 80% of the delayed discharges were attributable to medical reasons, which is exactly the same as in our study. Especially for patients having surgery on Thursday or Friday, the lesser availability of PT during the weekend could impact the mobilization and hence lead to delayed discharge due to mobilization issues.

As issues with mobilization and pain are not the case for the most patients, it can be argued that a general improvement in the fast-track protocol with better pain management and enhanced PT might not be an optimal use of resources. Instead, the subgroups with known risk factors for delayed discharge should be targeted with greater effort, as these efforts are more likely to yield results regarding both financial and patient satisfaction aspects especially with the increasing trend toward outpatient surgery.

Pain Medication

Due to the opioid crisis, different opioid-sparing measures have gained attention recently. Despite this, there is still no gold standard for treatment of postoperative pain after TKA, and the actual efficacy of many opioid-sparing modalities remain unclear [33]. The most common opioid-sparing strategies include multimodal pain management with non-opioid drugs (COX-2-inhibitors and other non-steroidal anti-inflammatory drugs, acetaminophen, gabapentinoids, corticosteroids etc.), peripheral nerve blocks, local infiltration analgesia, and physical interventions such as immobilization, elevation, and cryotherapy. New ways to reduce the need for opioids are continuously introduced. Some of the latest modalities include motor-sparing peripheral nerve blocks, such as the adductor canal block and infiltration between the popliteal artery and capsule of the posterior knee [34]. One cornerstone of the opioid-sparing protocol at our institution is using weak opioids instead of strong opioids at discharge. The use of weak opioids instead of strong opioids at discharge is not specific for total joint arthroplasty, and most likely reflects the culture of tight control of opioid prescription in Europe. Although it seems plausible that prescribing weak opioids instead of strong opioids reduces the risk of potential harmful effects, there is, to our knowledge, no convincing evidence that this is actually the case.

Future of Risk Scores

Some recent studies have looked at ways to determine which patients are suitable for outpatient total joint arthroplasty, and tools such as the Outpatient Arthroplasty Risk Assessment score have been developed [35]. Although the Outpatient Arthroplasty Risk Assessment score is based solely on comorbidities, other risk factors such as preoperative walking distance could also be used to develop even more accurate risk assessment tools. As we collect more and more "big data," artificial intelligence can help us develop and incorporate the risk assessment tools more easily into daily practice. Automated risk assessment is definitely the future for risk scores, and machine learning algorithms are already capable of predicting LOS and inpatient costs for individual patients [36].

Strengths and Limitations

The main strength of our study is that we were able to use first-hand data directly from patient medical records at a single high-volume arthroplasty center. Compared to other studies, our cohort was large, which provided sufficient statistical power to identify several risk factors. Also, as the healthcare system in our country is not profit-driven and everyone is insured by the government, potential confounders such as payer status did not influence our results. Furthermore, we used a standardized protocol for postoperative and discharge pain medication among all surgeons.

Our study has some limitations. First, due to the retrospective nature of the study, assessing the reasons for delayed discharge could be subject to some errors. To address this potential source of error, the patient medical records were scrutinized to conclude an accurate main reason for the delay. Second, the average LOS for different risk groups is an estimation of the effect, and might not hold true for individual patients. Finally, we did not include smoking history in the analyses, since this data was not reliably available. However, based on the results of a previous study smoking does not seem to be associated with prolonged LOS after TKA [37].

Conclusions

This study shows that it is possible to discharge TKA patients without strong opioids, and still maintain an LOS that is not inferior to what is commonly reported. The median LOS after elective primary TKA was 3 days (range 1-15). We identified 7 independent risk factors for an LOS longer than 3 days: age >75 years, high ASA score, preoperative walking distance less than 500 m, general anesthesia, day of surgery toward the end of the week, longer duration of surgery, and longer time spent in the PACU. Optimizing the use of hospital resources by targeting risk factors for prolonged LOS is highly relevant in the current healthcare setting with increasing cost-awareness and a shift toward outpatient TKA.

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